ANNEX IX

IMPLEMENTING AGREEMENT

BETWEEN

THE DEPARTMENT OF ENERGY OF THE UNITED STATES OF AMERICA

AND

THE MINISTRY OF ENERGY AND MINES OF THE REPUBLIC OF VENEZUELA

IN THE AREA OF

SUBSIDENCE DUE TO FLUID WITHDRAWAL

WHEREAS, the United States Department of Energy (hereinafter referred to as DOE) and the Ministry of Energy and Mines of Venezuela (hereinafter referred to as MEMV) desire to cooperate in the field of energy research and development;

WHEREAS, in the furtherance of their mutual interest DOE and MEMV entered into the Agreement in the field of Energy Research and Development signed March 6, 1980 (hereinafter referred to as the Energy R&D Agreement);

WHEREAS, DOE and MEMV have a mutual interest in technology exchange on the prediction of subsidence as a result of fluid withdrawal;

WHEREAS, DOE and MEMV have a mutual interest in improving their present modelling capability to predict the occurrence of cracks produced by subsidence due to fluid withdrawal

and/or removal of subsurface material;

WHEREAS, an ability to predict the occurrence of the potentially damaging effects of differential subsidence is of considerable value to many DOE and MEMV programs;

WHEREAS, near-surface cracking has been observed in oil fields of the Bolivar Coast, Venezuela, in response to discontinuous differential subsidence, providing a unique test area for the development and evaluation of predictive models for subsidence and horizontal deformation;

WHEREAS, some coastal dikes have been built to protect some inland areas presently below sea level at some densely populated zones and to maintain the oil and aquifer production from this area of the Maracaibo basin;

WHEREAS, approximately 80% of the Venezuelan daily petroleum production originates in the Maracaibo basin;

WHEREAS, the height of the coastal protection of the Maracaibo basin requires periodical increases, which along with indications of the near-surface cracks extending close to the dikes and the active seismicity of the area, pose appreciable risks to the populated areas and to the ability to sustain the petroleum

output from this region;

It is agreed as follows:

ARTICLE 1

In accordance with Article V of the Energy R&D Agreement, the Venezuelan representatives of the Steering Committee have designated INTEVEP, S.A. to act on behalf of MEMV under this Implementing Agreement. INTEVEP and DOE shall be hereinafter referred to as the Parties to this Implementing Agreement. The Assistant Secretary for Fossil Energy shall be primarily responsible for the programmatic aspects of this Implementing Agreement for DOE. Lawrence Livermore National Laboratory shall carry out DOE's technical responsibilities under paragraph A and B of Article 2 of this Implementing Agreement. Each party shall designate one Project Manager for this Implementing Agreement; these Project Managers shall provide technical management and coordination of the tasks described in this Implementing Agreement.

ARTICLE 2

The Parties shall cooperate in tasks in the area of subsidence due to fluid withdrawal as set forth below:

A. GEOPHYSICAL PROBING TO LOCATE NEAR-SURFACE CRACKING

Task 1. DOE shall provide INTEVEP with a detailed review of the geo-physical techniques that have merit for determining the nature of fractures at three specific sites on the Bolivar Coast. Each of the above sites shall be considered in terms of its own underground characteristics, such as saturation, fluid composition, and material-type. The techniques to be evaluated shall include, but shall not be limited to, surface based electromagnetic radar, electrical self-potential, two-loop mutual impedence, electrical resistivity, seismic transmission, excitation-of-the-mass, borehole-to-borehole signal-transmission, and seismic emission. This task is estimated to take six weeks following authorization by Project Managers to commence.

Task 2. INTEVEP and DOE shall jointly evaluate the various techniques for each application. The Project Managers shall prepare a feasibility study of a field test in Venezuela,

whereas a series of test areas in the Bolivar Coast will be chosen to test the probing techniques in the areas where fracture determination is needed. This task is estimated to take 8 weeks following the completion of task 1. A series of initial measurements by DOE shall be carried out using DOE equipment to verify the applicability of the method to each site. This process is estimated to take a period of 5 months following the completion of the Task 1.

Task 3. A report characterizing the results of the initial tests shall be written jointly by INTEVEP and DOE. The report shall include a plan jointly developed for continued probing to assess the specific sites on a periodic basis. The preparation of this report is estimated to take 1 month following the completion of task 2.

B. SUBSIDENCE PREDICTIONS

Task 1. The Project Managers shall determine to what extent existing first-order models predict the observed relationship between reservoir production and crack locations. The models shall be based on the following simplifications: 1) the reservoir compacts only vertically; 2) the pressure drop

occurs only in the reservoir; and 3) the overburden responds elastically. This approach shall be interpreted by assuming that cracks occur in the overburden where stress concentrations are highest.

Task 2. Existing data shall be compiled by INTEVEP with guidance from DOE for more detailed modelling of reservoir and overburden behavior. Data to be compiled may include: 1) surface elevations vs time; 2) subsurface compaction; 3) horizontal motions; 4) tilt information from oil tanks; and 5) reservoir pressure history information.

Task 3. Additional field data shall be collected by INTEVEP to use in subsidence models. DOE shall advise on measurement techniques and interpretation of data. Possible measurements include: 1) trilateration surveys to determine horizontal motions in the test area; 2) installation of vertical extensometers in wells; 3) repeated borehole gravity surveys to observe reservoir compaction.

Task 4. DOE shall develop and evaluate appropriate, field-based, higher level new models for predicting zones of crack occurrence, using data as specified in Task B1, and data from Tasks A1-A3, B2, and B3. The data may include time lag, pressure response in overburden, horizontal compaction in reservoir and lateral changes in properties.

Work on these four tasks of phase B is expected to commence on October 1983 and be carried out throughout the term of this Implementing Agreement.

C. THEORETICAL STUDIES ON COMPACTION

Task 1. DOE and INTEVEP shall jointly conduct an exhaustive review of the literature to establish the state-of-the-art with respect to conceptual and mathematical theories of compaction and its relationship to subsidence.

Task 2. DOE and INTEVEP shall jointly review the existing theories, laboratory methods, and field methods, and synthesize them into one state-of-the-art report.

ARTICLE 3

A. DOE shall contribute $25,000 in U.S. dollars to the cost of carrying out paragraph C of Article 2 of this Implementing Agreement, subject to the availability of appropriated funds. Except for the $25,000 contribution by DOE, all costs attributable to this Implementing Agreement, including but not limited to research, reports, travel, salaries and associated expenses, shall be borne by INTEVEP.

B. INTEVEP shall provide to DOE a financial contribution in U.S. dollars to support its share of the work in accordance with procedures to be identified by DOE prior to the first deposit.

C. Unless otherwise agreed by the Joint Steering Committee, the total amount to be paid by INTEVEP to DOE over the two-year period of this Implementing Agreement, subject to the availability of appropriated funds, shall not exceed the following amounts in U.S. dollars:

| | |
|---|---|
| Task A1 through A3 | $370,000 |
| Task B1 through B4 | $470,000 |
| Task C1 through C2 | $ 25,000 |

D. DOE shall be responsible for the transport, [illegible] safekeeping and insurance en route, of components [illegible] equipment to be used under Tasks A2, B2 and B3, [illegible] United States by plane or ship to an authorized [illegible] entry in Venezuela convenient to the ultimate de[illegible]n. INTEVEP shall reimburse DOE for all expenses inc[illegible] for the transport, including safekeeping and insuran[illegible] of these components and equipment. INTEVEP shal[illegible] sponsible for the transport, including safekeepi[illegible] insurance en route, of these components and equi[illegible] the authorized port of entry in Venezuela to th[illegible] destination and shall be responsible for the re[illegible] components and equipments, safekeeping and insu[illegible] route, to an authorized port of entry in the Un[illegible] convenient to the ultimate destination.

ARTICLE 4

The Parties shall support the widest possible [illegible] of information arising from this Implementing [illegible] accordance with Article 2 of the Annex to the [illegible] Agreement. If a Party has access to proprieta[illegible] as defined in Article 2 of the Annex to the E[illegible] Agreement which would be useful to the activit[illegible] Implementing Agreement, such information shal[illegible] for the tasks only on terms and conditions as [illegible] writing by the Parties.

ARTICLE 5

Rights to any invention or discovery made or conceived in the course of or under this Implementing Agreement shall be distributed as provided in paragraph 1 of Article VI of the Energy R&D Agreement. As to third countries, rights to such inventions shall be decided by the Joint Steering Committee.

Each Party shall take all necessary steps to provide the cooperations from its inventors required to carry out this Article. Each Party shall assume the responsibility to pay awards or compensation required to be paid to its own nationals according to its own laws.

ARTICLE 6

The existing terms and conditions of the Energy R&D Agreement shall continue and remain in full force and effect notwithstanding the terms of this Implementing Agreement. Articles 3, 4, 5, 6, 7, and 8 of the Annex to the Energy R&D Agreement are hereby incorporated by reference.

ARTICLE 7

This Implementing Agreement shall enter into force upon the later date of signature and shall remain in force for a period of two years. It may be amended or extended by mutual written consent of the Parties in accordance with Article V of the Energy R&D Agreement.

ARTICLE 8

This Implementing Agreement may be terminated at any time at the discretion of either Party, upon six (6) months advance notification in writing to the other Party by the Party seeking to terminate the Implementing Agreement. Such termination shall be without prejudice to the rights which may have accrued under this Implementing Agreement to either Party up to the date of such termination.

Done in Washington, D. C. and Caracas, Venezuela.

THE JOINT STEERING COMMITTEE

On behalf of DOE

Keith Frye

Member Keith Frye

George Stosur

Member George Stosur

Gordon Dean

Alternate Member Gordon Dean

6/17/83

Date

On behalf of MEMV

Jesus G Coronado

Member Jesus Garcia Coronado

Evanan Romero

Member Evanan Romero

Luis Giusti

Member Luis Giusti

12/JULY/1983

Date